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# An Announcement of **Highway Safety Literature** ... A Bi-Monthly Abstract Journal

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**HSL No. 72-8**  
**April 28, 1972**



**THIS ISSUE CONTAINS:**

HS-010 802 - HS-010 879  
HS-800 617 & 620  
HS-810 192  
HS-820 180

*U.S. Department of Transportation / National Highway Traffic Safety Administration*

An Announcement of  
**HIGHWAY SAFETY LITERATURE**  
... A Bi-Monthly Abstract Journal

Published twice-a-month by the National Highway Traffic Safety Administration,  
Research Institute, Office of Accident Investigation and Data Analysis  
Washington, D.C. 20590

**INTRODUCTION**

Publications such as journal articles, proceedings, and research reports announced in *Highway Safety Literature* include some of the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 72 designates the year and 1, 2, 3, etc. the individual issues. To aid the user in locating citations by the HS-number, the cover bears the inclusive entry number for each issue.

Entries in *HSL* are arranged according to the NHTSA Subject Category List shown in the Table of Contents. The list is a two-level arrangement consisting of five major subject fields subdivided into 59 subject groups. Documents related directly to

the National Highway Traffic Safety Administration (NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series), NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration. HS-800 000 series and HS-820 000 series are available for purchase from NTIS or GPO (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval.

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

**SAMPLE ENTRIES**

Subject Category Array —————→  
NHSB Accession no .... HS-800 218 Fld. 5/21; 5/9  
Title of document ..... AN INVESTIGATION OF USED CAR  
SAFETY STANDARDS-SAFETY  
INDEX: FINAL REPORT. VOL. 6 -  
APPENDICES G-L  
Personal author(s) ..... by E. N. Wells; J. P. Fitzmaurice; C. E.  
Guilliams; S. R. Kalin; P. D. Williams  
Corporate author ..... Operations Research, Inc.  
Collation —————→  
Publication date ..... 1969 150p  
Contract FH-11-6921  
Report no. ORI-TR-553-Vol-6; PB-190  
523  
Abstract ..... Appendices G-L to this study of used  
car safety standards include: indenture  
model diagrams for classes I-IV motor  
trucks; degradation, wear, and failure  
data for motor truck classes I-IV; and  
safety index tables for classes I-IV  
motor trucks.

Search terms; Wear; Trucks;  
Failures; Used cars; Inspection  
standards

**AVAILABILITY: NTIS**

**HS-004 497 Fld. 5/19**

**AUTO THEFT—THE PROBLEM AND  
THE CHALLENGE**

by Thomas A. Williams, Sr.

Journal citation ..... Published in *FBI Law Enforcement  
Bulletin* v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the auto  
theft problem and comments on anti-  
theft devices available now or in the  
planning stage.

Search terms: Theft; Theft pro-  
tection; Stolen cars

(Note: If the date of a report or  
Journal article is not given, the small  
letters nd will appear)

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\* All Federal Motor Vehicle Safety Standards apply to passenger vehicles. An asterisk before a subject group indicates additional types of vehicles to which the indicated standards may apply.

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NOTE: Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community. While brand names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval of any particular product, course, or equipment by the U.S. Department of Transportation, National Highway Traffic Safety Administration.

Harry A. Feinberg  
Managing Editor

## AVAILABILITY OF DOCUMENTS AND INSTRUCTIONS FOR ORDERING

Articles and reports whose citations and abstracts appear in HSL are acquired from many sources, such as periodicals, journals, NHTSA Contractors' reports and NHTSA staff speeches, and other reports. Those reports other than NHTSA Contractors' reports and NHTSA generated reports and speeches (see introduction) are assigned a lower consecutive accession (HS-) number.

Department of Transportation personnel may borrow copies of publications announced in HSL from the NHTSA Technical Reference Division. Non-DOT Personnel, in the Washington, D.C. area, may borrow copies of publications for a 24-hour period only. Telephone (202) 426-2768. Government personnel in the Washington, D.C. area, use government ID phone 118-62768.

The names of the journals cited in HSL appear in *italic type* preceded by the words "Published in." The journal containing the article cited may be borrowed from most research and public libraries. Non-DOT personnel outside the Washington area should contact their company or agency libraries for assistance.

NHTSA Contractors' reports and other reports can usually be obtained as indicated under AVAILABILITY. However, there is no certainty that copies will be available for more than a limited period after a report is issued.

The more common availability sources are identified by symbols which are explained in the next column:

NTIS: National Technical Information Service, Springfield, Va. 22151. Order by accession number: HS, AD, or PB. Prepayment is required by NTIS coupon (GPO coupons are not acceptable), check or money order (made payable to the NTIS). PC (Paper copy; full size original or reduced facsimile) prices are \$3.00 up to 300 pages, \$6.00 for 301 to 600 pages, \$9.00 for 601 to 900 pages, and over 900 pages will be quoted on request. Surcharge is added for foreign orders. MF (microfiche approximately 4x6" negative sheet film; reader required) is \$0.95 per report.

GPO: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Give corporate author, title, personal author, and report number. Prepayment is required by GPO coupon (NTIS coupons are not acceptable), check or money order (made payable to the Superintendent of Documents).

HRB: Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

NHTSA: National Highway Traffic Safety Administration, General Services Division, Washington, D.C. 20591 (Telephone (202) 426-0874), Give HS-No.

SAE: Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report numbers. Prices given are list; discounts are available to SAE members and sometimes to libraries and U.S. Government Agencies. Prepayment is required; orders received without payment are subject to a \$1 handling charge.

## IMPORTANT NOTICE

WHEN REQUESTING a document, to be absolutely sure you receive what you order, give the accession number (HS, PB, AD number) or report number (in cases such as an SAE document), title of report, and the personal or corporate author (whichever is cited). When requesting an HS-numbered document from NTIS, add DOT/to the prefix HS; example HS-800 000 should be ordered as DOT/HS-800 000.

**1/0 ACCIDENTS****1/1 Emergency Services****HS-010 802 Fld. 1/1****LES SECOURS AUX ACCIDENTS DE LA ROUTE (FIRST-AID TO ROAD ACCIDENT VICTIMS)**

by H. M. Verheye

Gendarmerie Belge

Published in HS-010 808, *Conference on Road Safety. Vol. 2. Biomechanics of Accidents, Pt. 2*, Brussels, 1968 pA18-(1-9)

11 refs

Text in French. Summaries in English, German and Dutch.

Adequate measures applied in time can save 40% of the victims likely to die after a road accident. The author examines questions relating to the teaching and application of first-aid (methods, equipment, means of transport, first-aid centers). The paper ends with a study of the possibilities afforded by the helicopter as a means of evacuating injured persons.

Search terms: First aid; Emergency training; Emergency equipment; Emergency reporting systems; Transportation of injured; Resuscitation; Ambulance personnel; Helicopter ambulances; First-aid equipment; Emergency medical services

**HS-010 803 Fld. 1/1; 1/2****TRAFFIC FATALITIES IN PHILADELPHIA**

by Joseph W. Spelman; Kenneth R. Bordner; John M. Howard

Published in *Journal of Trauma* v10 n10 p885-9 (Oct 1970)

1 ref

This study reviews 486 traffic accident victims covering the period 1964 through 1967. The purpose was to analyze the experience with a view to possible future improvements in emergency care, thus providing a sound base upon which a more effective emergency care system might be built. It was found that almost half of the victims were injured between 1 p.m. Friday and 9 a.m. Mondays. Earlier blood transfusion and more adequate and earlier respiratory support would probably have saved a number of lives.

Search terms: Fatalities; Autopsies; Accident survival time; Day of week; Time of accidents; Time of day; Fatality causes; Emergency medical services; Accident survivability; Medical treatment; Resuscitation; Blood transfusion

**HS-010 804 Fld. 1/1; 3/4****SAFE DRIVING OF AMBULANCES**

by Robert F. Hanlon

Published in *Hospital Topics* v46 p83, 85 (Jun 1968)

Defensive driving concepts for ambulance drivers are discussed. The importance of safe arrival, danger of excessive speed, right-of-way privilege, and the proper use of the siren are discussed, as well as typical kinds of accidents in ambulance driving.

Search terms: Ambulance personnel; Transportation of injured; Emergency vehicle accidents; Driver behavior; Driver performance under stress; Defensive driving

**1/2 Injuries****HS-010 805 Fld. 1/2****THE ENIGMA OF WHIPLASH INJURY**

by John D. States; Martin W. Korn; James B. Masengill

Published in *New York State Journal of Medicine* v70 p2971-8 (15 Dec 1970)

20 refs

Contract FH-11-7422

Presented at the 164th annual meeting of the Medical Society of the State of New York, New York City, 9 Feb 1970. Includes discussion by Michael J. Fontanetta.

Recent findings about the pathology of whiplash and engineering studies of instrumented crash tests of rear-end collisions are reviewed. Data from a clinical study of highway and racing accidents in which patients and the accident vehicles are examined, and preliminary data from an anthropomorphic study of the human neck are presented. Headrests represent one initial step in the reduction and prevention of neck injuries. Energy absorbing bumpers and rear body structures also promise to reduce neck injuries although they do not represent the whole answer to the problem. Seven whiplash case reports are given. Women appear more susceptible to whiplash than men.

Search terms: Neck motion range; Whiplash injuries; Cervical spine impact tolerances; Head restraints; Rear end collisions; Impact tests; Injury severity; Energy absorbing bumpers; Energy absorbing rear structures; Neck injuries; Injury case reports; Female injuries

**HS-010 806 Fld. 1/2****AN ENQUIRY INTO MOTORWAY FATALITIES**

by Stuart Bladon

Published in *Autocar* v134 n3930 p4-7 (22 Jul 1971)

# 1/2 Injuries (Cont'd.)

## HS-010 806 (Cont'd.)

Motorways have proved to be the safest roads in Great Britain. They have an excellent record for low numbers of accidents in relation to vehicle miles and traffic densities. But needless accidents with disastrous results still occur. Twenty-four people died on a 33-mile stretch of a Northamptonshire motorway in 1970. The lessons to be learned from a study of these accidents are that the major causes of accidents are driver inattention, vehicle defects, and excessive speed for the conditions of the road. Finally, seat belts should be worn: of the 24 deaths, six victims would have survived and five more would have had a fighting chance, had they worn their seat belts.

Search terms: High speed caused accidents; Failure caused accidents; Accident studies; Attention lapses; Defective vehicles; Accident rates; Great Britain; Fatality rates; Accident causes; Driver error caused accidents; Seat belt usage; Accident survivability

## HS-010 807 Fld. 1/2; 5/7

### POTENTIAL HEAD AND NECK INJURY FROM WINDSHIELD IMPACTS

by L. M. Patrick

Wayne State Univ.

Published in HS-010 808, *Conference on Road Safety. Vol. 2. Biomechanics of Accidents, Pt. 2*, Brussels, 1968 pA10-(1-24)

6 refs

Summaries in English, French, Dutch and German.

A series of dummy and cadaver experiments was conducted to establish whether neck and head injuries would be expected with the 30 mil HPR wind-

shield in a typical European automobile. Three different types of windshield installation were used: no restraint, rubber gasket, and bonded installation using a butyl tape. Head injuries from impacting the cowl were observed with the unrestrained and extruded rubber gasket installations. The accelerations measured on the back of the head in an A-P direction were below the brain damage level as interpreted by the WSU tolerance curve and the injury index for the first and second acceleration peaks. No bending or compression injuries to the cervical spine were observed by radiological examination or palpation.

Search terms: Cadavers in testing; Injury research; Dummies; Facial impact tolerances; Head impact tolerances; Impact caused injuries; Windshield impact tests; Windshield caused injuries; Volkswagens; Impact sleds; Windshield mounting; Popout windshields; Facial injuries; Head injuries; Neck injuries; Injury severity

# 1/3 Investigation

## HS-010 808 Fld. 1/3; 1/1; 1/2; 5/4; 5/7

### CONFERENCE ON ROAD SAFETY. VOL. 2 BIOMECHANICS OF ACCIDENTS, PT. 2

Fonds d'Etudes et de Rech. p.1a Sec. Rout. (Belg.)

1968 265p

Text in English, French, Dutch, and German. Includes HS-010 802, 807, 810, 832, 845, 856, 857, 871.

Eight articles are presented under the following titles: Potential head and neck injuries from windshield impacts; The windscreen and road safety; Utilization of thin glass, with high mechanical resistance, for the manufacture of high-security windcreens; Protection of

drivers of trucks and agricultural tractors in case of overturning or impact; The New York safety car, its evolution and its progress; Automobile collision and the effect of the new U.S.A. standards; Bus safety; and First-aid to road accident victims.

Search terms: Biomechanics; Emergency medical services; School bus safety; Occupant protection; Injury research; Windshield caused injuries; Safety standards; Safety cars; Injury prevention; Safety design; Truck overturn accidents; Farm tractor design; Truck design; Windshield impact tests; Glass tests; Glass caused injuries; Windshield design; Head impact tolerances; First aid; Neck impact tolerances

## HS-010 809 Fld. 1/3; 3/11; 1/2

### CHILD PEDESTRIAN ACCIDENTS IN CENTRAL HARLEM 1968

by Anthony Shaw; Azra Rezwi

Published in *Journal of Trauma* v11 n4 p295-300 (Apr 1971)

4 refs

It was found that the average child seriously injured in Harlem's streets was a six year-old boy. He was hit in May or June while running out from behind a parked car between intersections from 3 to 5 p.m. on a weekday. He was hit by a passenger vehicle with a male driver. He suffered a head injury and a fractured femur, and spent 16 days in the hospital. Different types of data which could highlight areas of significant accident incidence, as well as the associated factors relating to accidents are also required. Effectiveness of child safety education programs should be carefully evaluated.

Search terms: Pedestrian accidents; Pedestrian age; Pedestrian behavior; Pedestrian injuries; Child safety education; Head injuries; Femoral fractures;

Time of accidents; Pedestrian safety; Accident case reports; Children; Pedestrian fatalities; Injury severity; Accident factors

HS-010 810 Fld. 1/3; 5/14

# **AUTOMOBILE COLLISION AND THE EFFECT OF THE NEW U. S. A. STANDARDS**

by A. W. Siegel; A. M. Nahum

California Univ., Los Angeles

Published in HS-010 808, *Conference on Road Safety. Vol. 2 Biomechanics of Accidents, Pt. 2*, Brussels, 1968 pA15-(1-80)

23 refs

Summaries in French, Dutch and German.

The evolution of collision injury safety in modern American automobiles is traced. The effectiveness of several standards is described and collision examples are given where current performance standards are under study. Conclusions of detailed accident studies by medical-engineering teams at UCLA are presented. Reduced injury levels due to improved steering wheel/column systems, windshields, and other protective features are illustrated. The need for improved side impact protection and adequate child restraints is discussed. Cases are presented illustrating other problem areas, such as underride protection, seat anchorage failure, fuel tank rupture, hood latch failure, and windshield pillar failure. The need for further intensive medical-engineering collision research to be used as a basis for future performance standards is stressed.

Search terms: Photographs; Injury severity index; Accident research; Windshield caused injuries; Steering wheel caused injuries; Instrument panel caused injuries; Cardiothoracic injuries; Side impact collisions; Rollover accidents; Multidisciplinary

teams; Energy absorbing steering columns; Injury causes; Accident case reports; Impact velocity; Side impact bars; Child safety seats; Underride override collisions; Seat anchorages; Hood latch systems; Fuel tank rupture; Child injuries

## **2/0 HIGHWAY SAFETY**

### **2/1 Breakaway Structures**

HS-010 811 Fld. 2/1

### **BREDAWAY OVERHEAD SIGN BRIDGES, CRASH TESTING**

by D. L. Ivey; R. M. Olson; C. E. Buth; T. J. Hirsch; D. L. Hawkins

Published in *Highway Research Record* n346 p35-46 (1970)

2 refs

Sponsored by Committee on Traffic Safety Barriers and Sign, Signal and Lighting Supports and presented at the 50th annual meeting of the Highway Research Board.

This paper describes ten vehicle crash tests that were conducted on an overhead sign bridge. The purpose of these tests was to determine the feasibility of large breakaway supports for these bridges. The behavior of the overhead sign bridge when subjected to vehicle impact loads also was determined during this study. The vehicles ranged in weight from 2,100 to 5,170 pounds. Impact speeds ranged from 25.7 to 75.3 mph. These tests indicate that the breakaway safety features of the overhead sign bridge will greatly reduce the forces on impacting vehicles. The prototype structure remained erect and suffered only localized damage.

Search terms: Breakaway sign supports; Sign impact protection; Impact tests; Impact velocity; Impact forces; Overhead signs; Impact tolerances; Vehicle weight

HS-010 812 Fld. 2/1; 4/7

### **IMPACT RESPONSE OF OVER-HEAD SIGN BRIDGES MOUNTED ON BREAKAWAY SUPPORTS**

by J. E. Martinez; R. M. Olson; E. R. Post

Published in *Highway Research Record* n346 p23-34 (1970)

9 refs

Sponsored by the Committee on Traffic Safety Barriers and Sign, Signal and Lighting Supports and presented at the 50th annual meeting of the Highway Research Board.

General design considerations and the results of mathematical simulation of vehicle collisions with overhead sign bridges mounted on breakaway supports are presented. The results were obtained through the use of a mathematical model verified by seven full-scale crash tests. It was concluded that the application of the breakaway concept to the supports of an overhead sign bridge is feasible; that the prototype truss and the structure as a whole could withstand the impact; that vehicle velocity changes and deceleration rates increase as breakaway base and upper shear connection resistances increase; that occupants of small to medium vehicles might be injured in collision with the prototype support; and that larger vehicles were not severely damaged.

Search terms: Overhead signs; Impact tests; Mathematical models; Sign impact protection; Vehicle size; Simulation models; Injuries by vehicle size; Breakaway sign supports; Impact tolerances; Impact velocity; Torsion; Torque

## 2/4 Design and Construction

HS-010 813 Fld. 2/4

### ROAD SAFETY BY DESIGN

by T. D. Wilson

Published in *Journal of the Institution of Highway Engineers* v15 n5 p23-43 (May 1968)

21 refs

Presented at Conference on Highway Safety, London, Dec 1967. Includes discussion.

Road safety is built into road layout by design, openly, subtly, or even insidiously. This means more than two- or three-dimensional geometry, and must allow for the variable time factor, its influence on the driver, and the effect on his attitude to road safety. Much research information has been accumulated, from which new road standards have been evolved, and are being incorporated into new roads or used in interpreting improvements to existing roads. By having criteria for speed, space, and guidance and applying the yardstick of consistency to them, the highway engineer aims at a safe road layout which the driver can anticipate.

Search terms: Highway design; Highway design speed; Highway improvements; Highway engineering; Intersections; Traffic flow; Design standards; Safety design; Great Britain; Highway safety; Accident rates; Sight distances; Speed patterns; Highway signs; Pavement markings

HS-010 814 Fld. 2/4

### PERFORMANCE OF THE HI-DRO CUSHION CELL BARRIER VEHICLE-IMPACT ATTENUATOR

by Gordon G. Hayes; Don L. Ivey; T. J. Hirsch

Published in *Highway Research Record* n343 p93-9 (1971)

5 refs

Sponsored by Committee on Traffic Safety Barriers and Sign, Signal and Lighting Supports and presented at the 50th annual meeting of the Highway Research Board.

The barrier uses water-filled plastic tubes with orifices in the caps. Six full-scale crash tests were conducted to evaluate the effectiveness of the barrier as a vehicle-impact attenuator. The resulting test decelerations were substantially lower than those from a rigid wall test included for comparison purposes. Other full-scale tests conducted elsewhere have shown acceptable performance.

Search terms: Barrier collision tests; Energy absorbing barriers; Hydraulic barriers; Impact attenuators; Water cushions; Performance characteristics

HS-010 815 Fld. 2/4

### DYNAMIC TESTS OF AN ENERGY-ABSORBING BARRIER EMPLOYING WATER-FILLED CELLS

by Eric F. Nordlin; James H. Woodstrom; Robert N. Doty

Published in *Highway Research Record* n343 p100-22 (1971)

8 refs

Sponsored by the Committee on Traffic Safety Barriers and Sign, Signal and Lighting Supports and presented at the 50th annual meeting of the Highway Research Board.

The results of four full-scale vehicle-impact tests into energy-absorbing barriers using water-filled plastic cells and cartridges are reported. This barrier absorbs the energy of an impacting vehicle through the movement of water horizontally as the barrier is shortened and vertically through orifices as the flexible water cells and cartridges

are compressed. The recorded vehicle passenger-compartment decelerations indicated that, although unrestrained occupants would sustain moderate to severe injuries in most cases during 60-mph collisions with this barrier, fully restrained occupants would sustain little or no injuries during the majority of 60-mph impacts into the nose or side of the barrier. In addition, the barrier did not generate unstable vehicle behavior and, in conjunction with the bridge approach guardrail backstop, effectively redirected a vehicle impacting from the side.

Search terms: Barrier collision tests; Energy absorbing barriers; Hydraulic barriers; Dynamic tests; Water cushions; Impact attenuators; Performance characteristics

## 2/9 Traffic Control

HS-010 816 Fld. 2/9; 1/4

### INFLUENCE OF INCIDENTS ON FREEWAY QUALITY OF SERVICE

by Merrell E. Goolsby

Published in *Highway Research Record* n349 p41-6 (1971)

4 refs

Sponsored by Committee on Highway Capacity and Quality of Service and presented at the 50th annual meeting of the Highway Research Board.

This report quantifies, for the Gulf Freeway in Houston, the impact on operations by relating frequency, duration, and flow passing freeway incidents. Data were collected for weekdays only during daylight hours by utilizing the 6½ mile coverage of the Gulf Freeway television surveillance system. During a two-year period, 1,154 accidents and 1,117 stalls in moving lanes were observed. It was found that the average accident required 19 minutes from time of reporting to time of removal from traffic lanes, plus 26 minutes for police investigation.



Incidents created a flow reduction disproportionate to the physical reduction in roadway width. Average flow rate was 2,750 per hour with one lane blocked by an accident; 2,880 with one lane blocked by a stalled vehicle; 4,030 with an accident on the shoulder; and 1,150 with two lanes blocked by an accident. Delay for hypothetical morning peak period incidents are presented.

Search terms: Freeways; Traffic disturbances; Accident effect on traffic flow; Traffic impedances; Traffic flow; Traffic lanes; Traffic data analysis; Traffic characteristics; Peak hour traffic; Disabled vehicles; Debris removal; Time factors; Police response time; Accident location

**HS-010 817** Fld. 2/9; 3/11

### AAA SPECIAL SURVEY ON PEDESTRIAN SIGNALS

Anonymous

Published in *Pedestrian Safety Report* v1 n3 p1-6 (4 Jan 1971)

Most cities today use special pedestrian signals to supplement regular traffic control signals. The most common wording on special pedestrian signals is "WALK" and "DONT WALK" (85%). Some cities (14%) use "WAIT-WALK" and 1% "DONT START-WALK." The color green is used for "WALK" in 44% of the signals while white is used in 48%. The selection of the color of the "WALK" signal is directly related to the type of signal used. In gas-filled tubing signals, 64% use green—with incandescent signals, only 25% use green. For the "DONT WALK" signals 56% use red and 38% use orange. One out of three cities uses a flashing "DONT WALK" signal to warn pedestrians it is unsafe to begin crossing. Little or no experimentation or innovation in the development of special pedestrian signals was revealed through this survey.

Search terms: Pedestrian control signals; Signal uniformity; Flashing warning signals; Signal colors; Green; Red; Orange

**HS-010 818** Fld. 2/9; 4/7

### IMPROVED CRITERIA FOR TRAFFIC SIGNALS AT INDIVIDUAL INTERSECTIONS

by D. L. Gerlough; F. A. Wagner

Planning Research Corp.

1967 145p 95 refs  
Report no. NCHRP-32; NAS-NRC-Pub-1477

Sponsored by the American Assoc. of State Highway Officials in cooperation with the Bureau of Public Roads.

A simulation model representing traffic operations at an individual intersection has been developed and validated through field testing. A wide range of traffic characteristics was simulated to determine the effectiveness of various types of control, followed by field implementation of the most promising. A new and simple method of control, termed basic queue control, has produced encouraging results and compares favorably with the most sophisticated intersection controllers now in use. Intersection control incorporating various types of protected left-turn signal-phasing schemes has also been simulated, and the results illustrate the magnitude of the delays caused by using multiple-phasing arrangements. A comprehensive analysis is presented of traffic signal control concepts.

Search terms: Traffic simulation; Computerized simulation; Field tests; Traffic signal effectiveness; Punched cards; Traffic signal timing; Traffic signal delay time; Microscopic traffic flow models; Left turn signals; Queueing models; State of the art

studies; Traffic data analysis; Simulation models; Signalized intersections; Regression analysis; Travel time costs; Mathematical models; Driver vehicle interface; Flow charts; Computer programs

**AVAILABILITY:** HRB

## 3/0 HUMAN FACTORS

### 3/1 Alcohol

**HS-010 819** Fld. 3/1

### BLOOD ALCOHOL CONCENTRATIONS UPON ADMISSION TO A HOSPITAL CASUALTY DEPARTMENT

by T. J. Gay; R. L. Coates; G. L. Coggins; K. D. Alexander; J. Nayman

Published in *The Medical Journal of Australia* v2 p778-81 (24 Oct 1970)

6 refs

Over a period of seven days, blood alcohol concentrations were determined in 246 patients between the ages of 18 and 65 years who were admitted to the casualty ward at the Alfred Hospital, Melbourne. Seventy-five patients had alcohol in their blood, and of these, 21 had concentrations which exceeded 0.15 gm/100 ml. The results show the association of certain social factors with positive blood alcohol readings. The relationship of alcohol to motor-car accidents and diseases is also detailed. Charts showing sex, blood alcohol concentration, day of admission, nationality, and marital status are presented.

Search terms: Blood alcohol levels; Alcoholism; Age factor in accidents; Sex factor in accidents; Mental disorders; Marital status; Occupation; Sociological factors; Accident factors

**3/2 Anthropomorphic Data**

HS-010 820 Fld. 3/2

**FOOT OPERATION OF CONTROLS**

by K. H. E. Kroemer

Published in *Ergonomics* v14 n3 p333-61 (May 1971)

68 refs

Report no. AMRL-TR-69-57

Includes French and German summaries.

The literature pertaining to foot operation of controls is reviewed and a new experiment reported. Published experimental results clarify only some isolated aspects of leg and foot motions. Even the relatively often investigated speed of operating pedals and forces that can be applied to them, were studied under such different experimental conditions that no general statements are possible concerning what pedal can be operated most quickly or forcibly. Opinions about the advantages and disadvantages of hand versus foot operation seem not generally based on experimental findings. In an experiment, speed of specific leg and foot motions to targets was about 0.1 second; direction had no appreciable effect on accuracy.

Search terms: Reviews; Foot motion range; Hand motion range; Driver reaction time; Control location; Leg motion range; Pedal force; Males; Females; Anthropometry

HS-010 821 Fld. 3/2; 1/2; 5/14; 4/7

**DYNAMICS AND CUSHIONING OF HEAD IMPACT**

by Tsuyoshi Hayashi

Published in *Bulletin of the Society of Automotive Engineers of Japan* n3 p134-49 (Mar 1971)

9 refs

The purposes of this study are to analyze the dynamic response of the head and the intracranial pressure distribution for head impact, and to find main parameters governing head impact phenomena, to derive the criteria for human fatalities, and to study the effective method of head protection and cushioning. The research subjects and results were: theoretical analysis by a simplified one-dimensional model, solution of intracranial pressure distribution and its comparison with the test results; classification of head impact into "hard impact" and "soft impact" cases; more precise analysis of head impact, taking into account the mobility of spinal cord, and its comparison with clinico-pathological data; study of the rotational head impact.

Search terms: Impact forces; Head impact tolerances; Intracranial pressure; Head forms; Equations of motion; Cavitation; Brain injuries; Head impact velocity; Head protection; Mathematical models; Autopsies; Head movement; Simulation models

HS-010 822 Fld. 3/2; 4/7

**MOVEMENT OF AUTOMOBILE OCCUPANT IN COLLISION. MATHEMATICAL SIMULATIONS**

by Kazuo Higuchi; Masa-aki Morisawa; Takeshi B. Sato

Published in *Bulletin of the Society of Automotive Engineers of Japan* n3 p124-33 (Mar 1971)

3 refs

The behavior of automobile occupants during front-end and rear-end collisions is studied analytically with reference to the eight-degree-of-freedom mathematical model. The effects of the seat belt characteristics and the stiffness of the seat back and head restraint on occupant protection are described.

Search terms: Mathematical models; Head on collisions; Rear end collisions; Simulation models; Occupant modeling; Occupant kinematics; Stiffness; Mathematical analysis; Seat belts; Seat back kinematics; Head restraints; Degrees of freedom; Human body simulation; Equations of motion

HS-010 823 Fld. 3/2; 5/14; 4/7

**ANALYSIS OF OCCUPANTS MOVEMENTS IN REAR-END COLLISION**

by Hirosuke Furusho; Kazuo Yokoya; Syotaro Nishino; Satoshi Fujiki

Published in *Bulletin of the Society of Automotive Engineers of Japan* n3 p150-66 (Mar 1971)

3 refs

Assuming a mathematical model, occupant movements in rear-end collision were simulated. Comparing the results of mathematical simulation with the experimental data, fairly good agreement was obtained, and the assumption of the mathematical model employed was found to be reasonable. With this simulation, the effects of each element such as seat back, seat back cushion, head restraint, seat belt, seating posture and so on were investigated. It can be concluded from the results that to install head restraints is important to reduce the injury of occupants, and that the dimensions of various elements are fairly flexible due to human tolerance.

Search terms: Mathematical models; Occupant positioning; Rear end collisions; Simulation models; Human body simulation; Seat belts; Neck motion range; Human deceleration tolerances; Head restraints; Seat backs; Whiplash injuries; Head movement; Degrees of freedom; Head protection; Equations of motion; Mathematical analysis

**3/4 Driver Behavior**

HS-010 824 Fld. 3/4; 2/9

**THE DRIVER IN SINGLE LANE TRAFFIC**

by Donald A. Gordon

Published in *Highway Research Record* n349 p31-40 (1971)

11 refs

Sponsored by Comm. on Road User Characteristics and presented at the 50th annual meeting of the Highway Research Board.

Subject drivers impeded by an experimental car moving slowly on a single lane road showed three modes of response: (a) avoidance, where drivers moved backward out of the influence of the experimental car, 10% of the drivers; (b) car-following, where drivers stayed close to the experimental car and did not execute large backward or forward movements, 30% of the drivers; and (c) a combination of avoidance and car-following, 60% of the drivers. Drivers' lead distance patterns did not conform to Herman's car-following equation. The equation may apply better to the situation where a driver reacts to disturbances introduced by the car in front. Drivers also showed an indifference threshold for lead distance.

Search terms: Driver behavior; Single lane traffic; Photography; Car following; Following distance; Mathematical models; Slow moving vehicles; Speed studies; Traffic impedances

HS-010 825 Fld. 3/4; 3/5

**TRAFFIC ACCIDENT PROBLEMS AND EXPOSURE CHARACTERISTICS OF THE AGING DRIVER**

by Thomas W. Planek; Richard C. Fowler

Published in *Journal of Gerontology* v26 n2 p224-30 (Apr 1971)

8 refs

The records of several thousand drivers aged 55 or more were studied, together with questionnaires from 3,633 drivers in this age group. Frequency of driving, rush hour driving, driving in darkness, winter driving, and driving on particular types of roads were examined. The driving patterns of female and male drivers are described. Aging drivers' perceptions of their problems differ from the accident and violation patterns shown by the records of this group. They do not perceive that inattention is of major importance. Education of the aging driver should aim at reducing the need for adaptive reactions that require a series of rapid judgments and maneuvers. There is a problem of stimulus overload especially for drivers over 65.

Search terms: Questionnaires; Age factor in driving; Night driving; Winter driving; Driver reaction time; Aged drivers; Attention lapses; Driver mileage; Driver education; Driver attitudes; Driver records; Accident rates; Peak hour traffic; Driver age; Driver sex; Male drivers; Female drivers; Traffic law violations; Perception

**3/5 Driver Education**

HS-010 826 Fld. 3/5

**IN REPLY TO DR. GOLDSTEIN**

by Frederick L. McGuire

Published in *Journal of Safety Research* v1 n4 p165-9 (Dec 1969)

3 refs

This is an answer to criticism of *An Evaluation of Driver Education, A Study of History, Philosophy, Research Methodology, and Effectiveness in the Field of Driver Education*, by Frederick L. McGuire and R. Kersh. The author

defends his research methods and conclusions. He contends that it cannot be proved that high school driver education courses will reduce accidents.

Search terms: High school driving courses; Driver education evaluation; Accident prevention

HS-010 827 Fld. 3/5; 5/20

**CAUTION: UNSAFE OPERATION OF THIS VEHICLE MAY BE HAZARDOUS TO YOUR HEALTH**

by Leslie Greenwood

Published in *Commercial Car Journal* v120 n5 p57-61 (Jan 1971)

One of the largest tank line motor carriers runs a safe and profitable operation that stresses safety awareness. Driver training and safety award incentives are an integral part of the safety program; handling corrosive or hazardous materials is daily routine. Periodic retraining keeps drivers and mechanics alert, while preventive maintenance and inspection ensure safe equipment on tractors and trailers.

Search terms: Tank trucks; Fleet driver training; Motor carriers; Truck maintenance; Truck drivers; Preventive maintenance; Fleet safety; Fleet management; Hazardous materials; Safety programs

**3/6 Driver Licensing**

HS-010 828 Fld. 3/6; 3/9

**OKLAHOMA'S MEDICAL ADVISORY COMMITTEE FOR DRIVER LICENSING**

by R. LeRoy Carpenter; Marvin K. Margo

**3/6 Driver Licensing (Cont'd.)****HS-010 828 (Cont'd.)**

Published in *Journal of the Oklahoma State Medical Association* v62 p396-8 (Aug 1969)

4 refs

A Medical Advisory Committee to the Department of Public Safety created by state statute has been working since 1968 in Oklahoma. Experience has revealed that a large number of persons, heretofore unable to be licensed due to physical disabilities, has been able to retain driving privileges with certain restrictions and periodic medical re-evaluation by physicians of their own selection. Private practitioners should keep in mind the potential driving hazards in their patients with certain physical and emotional conditions and collaborate with the Medical Advisory Committee when appropriate. During its first year, the committee reviewed 404 cases and granted 309 licenses, of which 59 were restricted.

Search terms: Medical advisory boards; Disability evaluation; Driver license standards; Driver mental fitness; Driver physical fitness; Handicapped drivers; Oklahoma; Driver license restrictions

**4/0 OTHER SAFETY-RELATED AREAS****4/7 Mathematical Sciences****HS-010 829 Fld. 4/7****AN EVALUATING METHOD FOR THE CORRELATION BETWEEN LOAD AND LIFE ESTIMATE OF VEHICLE COMPONENTS**

by Hiroshi Kambara; Tatsuo Togawa

Published in *Bulletin of the Society of Automotive Engineers of Japan* n3 p117-23 (Mar 1971)

2 refs

This paper deals with an estimation method of life for vehicle components, applying Weibull distribution function to the frequency distribution service stress. The estimation, which has been made in each case of different component or driving condition, is generalized and simplified with a non-dimensionalized S-N diagram of material. In this method, the fatigue damage factor can be quickly found by the diagram which consists of the distribution shape parameter  $m$  and material strength parameter  $\alpha$ . At the same time, the estimation of the allowable stress in safe-life design and the evaluation of driving condition are easily established by use of these parameters from the standpoint of fatigue damage of components. The method is related to acceleration and road roughness.

Search terms: Weibull density functions; Automotive parts; Failure stress; Stress strain characteristics; Fatigue life; Service life; Loads (forces); Parameters; Acceleration tolerances; Surface roughness; Road surfaces

**HS-010 830 Fld. 4/7; 5/4****VIBRATION CHARACTERISTICS OF BODY EXTERNAL PANEL OF AUTOMOTIVE VEHICLE**

by Hiromichi Nakamura; Shunji Matsui; Tadashi Hayashi

Published in *Bulletin of the Society of Automotive Engineers of Japan* n3 p93-101 (Mar 1971)

4 refs

It is extremely difficult to conduct an exact analysis of the vibration characteristics of the body external panel of an automotive vehicle; however, the authors made it possible to conduct the closest approximate calculation of the resonance frequencies of the body external panel by giving a proper choice of dimensions in accordance with the specifications of this particular panel and also with boundary conditions of the

vibratory motions and replacing the actual panel with a rectangular curved panel provided with a constant radius of curvature.

Search terms: Bodies; Vibration analysis; Resonant frequency; Mathematical analysis

**5/0 VEHICLE SAFETY****5/1 Brake Systems****HS-010 831 Fld. 5/1****TAKING THE SKID OUT OF BRAKING**

by Anthony Curtis

Published in *New Scientist and Science Journal* v51 n764 p358-61 (12 Aug 1971)

The development of antilock brake systems is described. Within the next several years these systems will appear more widely on production cars. They reduce the possibility of skidding or loss of control in wet, slippery, and icy conditions. While the antilock braking concept is at least twenty years old, the newer systems are electronically controlled. Safety and reliability problems of antilock brakes are discussed.

Search terms: Antilocking devices; Antiskid brakes; Brake performance; Skid control; Electronic braking; Loss of control; Wet road conditions; Icy road conditions; Reliability

**5/2 Buses, School Buses, and Multipurpose Passenger Vehicles****HS-010 832 Fld. 5/2****BUS SAFETY**

by T. J. Mulcahy

Dublin Dept. of Local Government (Ireland)

Published in HS-010 808, *Conference on Road Safety, Vol. 2, Biomechanics of Accidents, Pt. 2*, Brussels, 1968 pA16-(1-39)

51 refs

Summaries in French, German and Dutch.

Four specific bus safety problems are considered with particular attention to school buses, namely driving visibility, identification of the vehicle when stopped or slowly moving, seats and seating accommodation, and emergency evacuation. An examination is made of how best the latest research findings, especially the U.C.L.A. test results, might be applied economically by a government regulatory body to a bus safety program. The role of government in the safety field, both nationally and internationally, is discussed and policy guide lines indicated.

Search terms: Bus design; Visibility; Windshield design; Reduced visibility; Windshield glare; Mirrors; Escape from vehicle; Pedestrian safety; School bus safety; School bus passengers; Ireland; Field of view; School bus design; School bus signals; Seat design; Child safety education; Velocity perception; Federal role

#### 5/4 Design

HS-010 833 Fld. 5/4

#### FLAME SPRAYING TECHNOLOGY

by David C. Radford

Published in *Journal of Automotive Engineering* v2 p3-6 (Apr 1971)

Flame spraying is a process in which a material is brought to its melting point

and propelled in a molten or heat-softened condition on a substrate to form a coating. In the motor industry the process has found application in the coating of piston rings, gears, and other components in which wear resistance plays an important part. The metallurgical structure resulting from flame spraying reacts mechanically and physically with the substrate, setting up stresses which ultimately limit the thickness of the sprayed layer. Methods of application are described including automated spraying systems, which are becoming increasingly popular, and which overcome some of the hazards of manual application.

Search terms: Coatings; Spraying; Deposition; Metal working; Physical properties; Bonding; Piston rings; Gears; Wear resistance; Flame spraying

HS-010 834 Fld. 5/4

#### COMPARATIVE CAR TESTING

by Michael Hall

Published in *Journal of Automotive Engineering* v2 p7-11 (Apr 1971)

3 refs

For nearly ten years *Motoring Which*, the quarterly motoring supplement to *Which* magazine, has undertaken the comparative testing of cars to provide its readers with a ready means of drawing comparisons between vehicles of similar price and function. To meet the special requirements of this type of testing and time limitations imposed by press deadlines, the *Motoring Which* team of engineers and drivers has evolved a system of testing whereby such features as performance, economy, reliability, comfort, handling, noise, and safety can be assessed in terms which can be understood by the average non-technical consumer. Acceleration, handling, and noise test are described.

Search terms: Automobile performance; Automobile tests; Automobile handling; Test equipment; Consumer education; Vehicle noise; Vehicle acceleration tests

HS-010 835 Fld. 5/4

#### A RATIONAL APPROACH FOR CALCULATION OF HEAT TRANSFER IN DIESEL ENGINES

by G. Sitkei; G. V. Ramanaiah

Central Mechanical Engineering Res. Inst. (India)

1972 11p 25 refs  
Report no. SAE-720027

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

This paper proposes a new equation for calculating instantaneous heat transfer in internal combustion engines. The equation constitutes expressions of heat transfer due to convection, and gas and flame radiation. In the term for convective heat transfer three sets of parameters appear: operating parameters (pressure in the combustion chamber, mean piston speed, gas temperature), an engine parameter (equivalent diameter of the cylinder), and a constant that takes swirl velocities (at the time when combustion starts) into account. Consideration of gas radiation and data obtained on flame radiation make the equation broadly complete, scientifically sound, and universally applicable.

Search terms: Diesel engines; Heat transfer; Test equipment; Gas radiation; Flame radiation; Convection; Equations; Engine operating conditions; Combustion chamber swirl

AVAILABILITY SAE

HS-010 836 Fld. 5/4

**EXPERIMENTAL DETERMINATION OF AIRFLOW PATTERNS IN PISTON ENGINES WITH INDUCTION SWIRL**

by K. H. Huebner; A. T. McDonald

General Motors Res. Labs.; Purdue Univ.

1972 20p 11 refs  
Report no. SAE-720026

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

A dynamic model of a piston engine has been developed to study cylinder air motion during the intake stroke. Flow visualization and paddle wheels were used to study gross flow patterns. Detailed maps of velocity at several instants during the intake stroke were obtained using hot-wire instrumentation. The model and measurement technique are described briefly. Results are presented for inlet swirl generated by streamlined port and shrouded valve configurations. Gross swirl measurements made with paddle wheels are compared with those computed from the velocity profile measurements. The effects of engine speed, compression ratio, and measuring location in the cylinder are discussed. The results show that measuring devices must be selected carefully to produce reliable data. Gross swirl measurements be interpreted with caution, using guidelines presented here.

Search terms: Piston engines; Cylinders; Intake valves; Engine speeds; Air induction; Air flow; Compression ratio; Dynamic models; Combustion chamber swirl; Ports (openings); Engine performance; Engine tests; Research methods

**AVAILABILITY: SAE**

HS-010 837 Fld. 5/4

**POLYESTER MOULDING COMPOUNDS. PT. 2. MOTOR VEHICLE APPLICATIONS**

by Elwyn Davies

Published in *Journal of Automotive Engineering* v2 p15-8 (Jun 1971)

In Part 1, the author described mechanical and physical properties of dough and sheet molding compounds (DMC's and SMC's). Part 2 is on automotive applications of these materials, of which 28,000 tons were used in passenger cars in the United States in 1969. Body and engine parts are considered, and the author considers how the scope of DMC's and SMC's can be increased in European production. Compared with hand layed-up polyester glass fiber materials, these compounds offer a much quicker production cycle and the ability to produce more complex shapes which have in many cases replaced components traditionally produced from sheet steel and light alloy die castings.

Search terms: Polyester; Glass fiber reinforced plastics; Molding; Physical properties; Mechanical properties; Automobile materials; Automobile engines; British vehicles

HS-010 838 Fld. 5/4

**STEADY AND CYCLIC THERMAL STRESSES OF DIESEL ENGINE PISTONS—A PHOTOTHERMOELASTIC STUDY AND CALCULATION**

by M. Mihara; T. Kokubu; K. Hirata

Mitsubishi Heavy Industries Ltd. (Japan)

1972 13p 17 refs  
Report no. SAE-720025

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

A photothermoelastic analysis was used to investigate the steady thermal stresses

of the pistons of 4-cycle, high-speed diesel engines, and the cyclic temperature swing of the piston surface in relation to the cyclic thermal stresses was investigated with a digital computer method. The investigation revealed that axisymmetric analysis as an approximation was enough to estimate the steady thermal stresses, and that a major cause of the stress was the radial thermal gradient in the top of the pistons. The cyclic temperature swing and cyclic thermal stress, calculated in connection with time-averaged heat flux, reached considerably higher value than that calculated by usually used equations of instantaneous heat-transfer coefficient.

Search terms: Diesel engines; Pistons; Thermal stresses; Heat flux; Elasticity; Thermal factors; Digital computers

**AVAILABILITY: SAE**

HS-010 839 Fld. 5/4

**AUTOMOTIVE ELECTRONICS IN THE 1970'S**

by H. G. Riggs

General Motors Corp.

1970 22p

Problems in applying electronics to automotive vehicles are outlined. Electronics will meet future design needs well. The electronics industry should develop components and systems of lower cost and higher reliability and help the automotive industry to achieve the full potential of electronics in the auto. Problems discussed include lead time, innovation, great variety in driving conditions, servicing of electronic systems.

Search terms: Electronic devices in vehicles; Integrated circuits; Transistors; Solid state devices; Reliability; Automobile design; Lead time; Innovation; Automobile maintenance; Driving conditions; Miniaturization; Automatic control; Control equipment

HS-010 840 Fld. 5/4

# LINERLESS ALUMINUM CYLINDERS

by Maurice Platt

Published in *Journal of Automotive Engineering* v2 p3-8 (Mar 1971)

4 refs

The introduction of the new Chevrolet Vega with its 2.3 liter linerless aluminum engine has opened up many possibilities for the production of engines with aluminum pistons running directly in aluminum bores. Development and production of this linerless engine is described. The method of manufacture may result in costs competitive with cast iron and could be used to advantage in Europe.

Search terms: Engine design; Vega; Cylinders; Aluminum alloys; Automobile materials; Die casting; Pistons; Metal working; Physical properties; Engine size; Automobile costs; European vehicles

HS-010 841 Fld. 5/4

# EXPERIMENTAL VERIFICATION OF FREQUENCY PARAMETER IN PLATE-TYPE VISCOUS FLOW METERS IN AIR CONSUMPTION MEASUREMENTS OF INTERNAL COMBUSTION ENGINES

by H. Sezgen; M. Ozsoy

Orta Dogu Teknik Univ. (Turkey)

1972 12p 13 refs  
Report no. SAE-720028

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

Precise air consumption measurement is of vital importance in the development

of internal combustion engines. Considerable errors are introduced in measurements of airflow rates when conventional flow meters are used under pulsating flow conditions. Plate-type viscous flow air meters have been used satisfactorily under certain speed ranges. But it was found that the linear relationship between the flow rate and the pressure drop across the viscous flow air meter deviated at high engine speeds under the pulsating flow conditions found in internal combustion engines. Viscous flow meters have been designed using two main equations—pressure drop and Reynolds number equations. Deviation from linear relationship at higher speeds has led to an attempt at experimental verification of the frequency parameter theoretically analyzed previously. Experimental results have shown that there is an exponential relationship between the frequency parameter and the distance between two adjacent plates of a viscous flow air meter which has to be considered in design calculations.

Search terms: Internal combustion engines; Flowmeters; Air flow; Engine speeds; Pressure responses; Reynolds number; Equations; Engine air consumption measurement; Air flow rates

AVAILABILITY: SAE

HS-010 842 Fld. 5/4; 4/7

# A NEW METHOD OF CALCULATING PLAIN BEARINGS OF STATICALLY INDETERMINATE CRANKSHAFTS

by Eglof von Schnurbein

Motoren- und Turbinen-Union  
Friedrichshafen GmbH

1970 12p 6 refs  
Report no. SAE-700716

Presented at Combined National Farm, Construction and Industrial Machinery

and Powerplant Meetings, Milwaukee, 14-17 Sep 1970.

The standard methods for the calculation of the main bearing forces for multiple (that is, statically indeterminate) supported crankshafts are based on considerably simplified assumptions. Thus the results of the calculations are not representative of actual working forces. The new, improved method considers the crankshaft as a straight beam on plain bearings. With this system the forces and dislocations of all bearings influence each other, since the distribution of the operational forces over the individual bearings depends on the crankshaft deformation and therefore on each journal within the bearing. Therefore the forces and dislocations are matched to each other by iteration. A comparison of calculation results with measurements shows a substantial improvement over the methods commonly used.

Search terms: Journal bearings; Crankshafts; Bearing tests; Mathematical models; Mathematical analysis; Displacement; Force

AVAILABILITY: SAE

HS-010 843 Fld. 5/4; 4/7

# ANALOG COMPUTATION OF PRESSURE EVOLUTION IN INTERNAL COMBUSTION ENGINES

by K. Aprameyan; M. Murat

Paris Univ. (France)

1972 12p 4 refs  
Report no. SAE-720029

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

A philosophy is proposed that there might exist a definite correlation between the engine parameter variations and the Fourier coefficients of different

# 5/4 Design (Cont'd.)

## HS-010 843 (Cont'd.)

harmonics of the corresponding pressure diagrams and their derivatives. It is thus possible to establish the law of variation of Fourier coefficients with respect to a particular parameter. From these correlations, it is possible to predict a cycle, taking into consideration all the important parameters— injection timing, load, speed, flow processes, etc. Harmonic analyses developed in the laboratory are based on the principles of analog computation, to get results instantaneously, while the engine is running on the test bed.

Search terms: Internal combustion engines; Analog computers; Fourier analysis; Engine performance; Mathematical models; Computerized simulation; Pressure responses; Fuel injection; Fuel flow

AVAILABILITY: SAE

HS-010 844 Fld. 5/4; 4/7; 5/15

## THEORETICAL AND EXPERIMENTAL STUDIES OF DIE CASTING TECHNIQUES FOR SMALL ENGINE CONNECTING RODS

by R. B. Weatherwax; Otto K. Riegger

Tecumseh Products Co.

1971 9p 6 refs

Report no. SAE-710600

Presented at the SAE Mid-Year Meeting, Montreal, 7-11 Jun 1971.

A computerized solidification model based on heat transfer theory has been developed for application to die castings to improve their reliability. The model was applied to a small engine connecting rod to investigate the effects of uniform die temperatures, die temperature gradients, insulated coring, melt temperatures, and gate location on solidification patterns. The simulation

results indicate that directional solidification cannot be achieved with reasonable die temperature gradients, but can be with a combination of proper gate location and die temperature control. The quality of the connecting rod casting was improved through an instrumentation study of casting variables and by changing gate location and casting procedures as suggested by the solidification model.

Search terms: Die casting; Molding; Strength (mechanics); Mathematical models; Connecting rods; Computerized simulation; Heat transfer; Thermal factors; Simulation models; Reliability

AVAILABILITY: SAE

HS-010 845 Fld. 5/4; 5/14

## THE NEW YORK SAFETY CAR. ITS EVOLUTION AND ITS PROGRESS

by B. Y. Scott

New York State Dept. of Motor Vehicles

Published in HS-010 808, *Conference on Road Safety. Vol. 2. Biomechanics of Accidents, Pt. 2*, Brussels, 1968 pA14-(1-35)

Summaries in French, Dutch and German.

New York State has proceeded from the original concept of a safety car, in 1960, to the creation of the Safety Sedan—a practical, life-saving vehicle that can prevent accidents and injuries, and can be mass-produced for public use. The program includes all classes of vehicle safety: accident prevention, crash injury prevention, pedestrian injury prevention, rescue and post-crash safety, and non-operating safety systems (to protect pedestrians, passengers, or maintenance personnel when the vehicle is not operating). The safety level is defined by an overall safety rating and by simplified ratings of individual types of safety

performance. The next steps for completion of the program are developed.

Search terms: Safety cars; Safety design; Crashworthiness; Accident avoidance; Injury prevention; Automobile bodies; Safety devices; Occupant protection; Impact protection; Pedestrian safety; Postcrash phase; Safety engineering; Automobile design

HS-010 846 Fld. 5/4; 5/14

## DESIGN FOR SAFETY

by R. H. MacMillan

Published in *Journal of Automotive Engineering* v2 p5-8 (Feb 1971)

Research on primary safety is concerned with accident prevention; on secondary safety, with protection of occupants. Evaluation of primary safety is difficult, since it requires estimation of accidents prevented, and drivers in safer car/road situations tend to drive faster. Research being done in various aspects of primary safety is outlined. Secondary safety has been receiving greater attention, especially in the United States. Research on deceleration tolerances and restraint systems is outlined. Safety legislation and compliance tests are briefly discussed.

Search terms: Highway safety; Vehicle safety; Accident prevention; Occupant protection; Restraint systems; Deceleration tolerances; Compliance tests; Safety laws; Safety research

HS-010 847 Fld. 5/4; 5/17; 4/7

## ADAPTING MATERIAL DATA TO DESIGN

by R. Bruce Hopkins

Deere and Co.



1970 12p 19 refs

Report no. SAE-700557

Presented at Earthmoving Industry Conference, Central Illinois Section, Peoria, 14-15 Apr 1970.

In product design and development it is necessary to compare operating stresses to material strength properties in order to estimate the durability of the various components. The effects of material hardness, surface finish, section size, and presence of stress concentrations on the fatigue properties of steel, cast irons, sintered irons and steels, and aluminum are discussed. Because a material specification normally includes a range of strength properties, a method is suggested for constructing an estimated S-N curve based upon a selected strength level. The method is extended to construct an S-N curve for an approximate failure rate of the selected strength level. The construction of failure diagrams for irons and steels is discussed. Use of the true fracture strength instead of the ultimate tensile strength is suggested for construction of modified Goodman diagrams for ductile materials.

Search terms: Fatigue (materials); Fatigue tests; Materials tests; Hardness; Stress analysis; Steels; Iron; Failure stress; Mathematical models; Tensile strength; Ultimate strength

AVAILABILITY: SAE

HS-010 848 Fld. 5/4; 5/20

### BIAS BALANCING INTERAXLE DIFFERENTIAL FOR CONSTANT 4-WHEEL DRIVE

by D. E. Hobson; L. J. O'Brien

Dana Corp.

1971 7p 1 ref

Report no. SAE-710616

Presented at the SAE Mid-Year Meeting, Montreal, 7-11 Jun 1971.

Limitations of current four-wheel drive systems for hard surface operation are analyzed. Requirements for off-road mobility are studied and the requirements for a biased interaxle differential are defined from those requirements. The design and test of a biased differential which can be tailored to specific requirements are discussed.

Search terms: Differential design; Power trains; Off the road vehicles; Vehicle design; Four wheel drives; Vehicle performance; Interaxle differentials; Torque; Cornering;

AVAILABILITY: SAE

### 5/6 Fuel Systems

HS-010 849 Fld. 5/6

### UNLEADED VERSUS LEADED FUEL RESULTS IN LABORATORY ENGINE TESTS

by E. J. Fuchs

Lubrizol Corp.

1971 30p 19 refs

Report no. SAE-710676

Presented at the SAE National West Coast meeting, Vancouver, Canada, 16-19 Aug 1971.

A test program was conducted using a wide variety of laboratory oil and fuel performance test procedures in order to compare effects of unleaded fuel versus leaded fuel. Initial results have indicated that unleaded fuel is more severe than leaded fuel with respect to varnish deposits, full throttle octane requirement increase, exhaust valve seat wear, and wear of certain other engine components. Results have also shown unleaded fuel to be less severe on rust deposits, spark plug fouling, and oil thickening due to oxidation. Sludge deposits were only slightly less severe with unleaded fuel. Experiments with exhaust gas recirculation for nitrogen oxide control showed that suitable

crankcase oils can counteract possible detrimental engine deposits.

Search terms: Lead free gasoline; Leaded gasoline; Exhaust gas recirculation; Engine tests; Engine deposits; Engine wear; Engine operating conditions; Octane requirements; Spark plugs; Laboratory tests; Wear tests

AVAILABILITY: SAE

HS-010 850 Fld. 5/6

### NITRO-OLEFINS, COMBUSTION PRODUCTS OF HYDROCARBONS. 3. 3-NITRO-2-METHYL-2-BUTENE, A COMBUSTION PRODUCT OF 2-METHYL-2-BUTENE

by Jonathan Wasserberger; Jack L. Radomski; Wm. B. Deichmann

Published in *Industrial Medicine and Surgery* v39 n5 p225-8 (May 1970)

18 refs

Gas chromatographic analysis of the exhaust obtained from the combustion of pure 2-methyl-2-butene (the principal olefin in a premium grade gasoline) revealed the presence of the corresponding nitro-olefin, 3-nitro-2-methyl-2-butene. An indication of the possible presence of this nitro-olefin in the combustion products of gasoline was obtained. However, attempts at isolating and positively identifying the peak corresponding to this nitro-olefin were unsuccessful. The possible role of nitro-olefins as potential air pollutants is discussed.

Search terms: Gas chromatography; Air pollutants; Nitroolefins; Hydrocarbons; Air pollution effect on health; Olefins; Exhaust emission tests; Exhaust gases; Exhaust effect on health; Fuel combustion; Butene

## PRECOMBUSTION CHAMBER DIESEL ENGINE EMISSIONS—A PROGRESS REPORT

by R. E. Bosecker; D. F. Webster

Caterpillar Tractor Co.

1971 13p 7 refs  
Report no. SAE-710672

Presented at the SAE National West Coast Meeting, Vancouver, 16-19 Aug 1971.

Precombustion chamber engines are among the lowest emission power sources available today. Due to excellent fuel-air mixing and complete combustion, HC and CO emissions are extremely low. Levels of NO<sub>2</sub> are also relatively low because of the divided chamber quench effect. Because of the low HC and CO levels, effort has been concentrated on lowering NO<sub>2</sub> levels. Retarded timing and inlet air cooling through the use of aftercoolers, water induction, and exhaust recirculation have all shown beneficial results. Smoke levels are minimized by selective matching of engine and turbocharger to assure adequate air for combustion.

Search terms: Precombustion chamber engines; Vehicle air pollution; Diesel engine exhaust emissions; Smoke; Exhaust emission control; Hydrocarbons; Carbon monoxide; Nitrogen oxides; Emission standards; California; Water injection; Cooling systems; Quench phenomenon; Exhaust emission tests; Exhaust gas recirculation; Exhaust emission control devices; Combustion

AVAILABILITY: SAE

HS-010 852 Fld. 5/6

## SOME EFFECTS OF FUEL INJECTION SYSTEM PARAMETERS ON DIESEL EXHAUST EMISSIONS

by R. S. Ford, D. F. Monahan, M. S. Ford

General Motors Corp.

1971 11p 8 refs  
Report no. SAE-710671

Presented at the SAE National West Coast Meeting, Vancouver, 16-19 Aug 1971.

The products of diesel combustion, including hydrocarbons, nitric oxide, carbon monoxide, and exhaust smoke are being controlled by current and future emission standards of federal and state governments. Fuel injection parameters, including tip design, injection timing, rate of injection, and the number and size of tip orifices were investigated with the unit injector, used in Detroit diesel engines, for influence on these emissions. Results are presented to show control of hydrocarbon emissions by injector tip design. Reduction in nitric oxide emissions by changing injection parameters is limited by increased exhaust smoke and carbon monoxide and losses in fuel economy. Emissions were reduced to below the level required by the 1973 California standard.

Search terms: Vehicle air pollution; Diesel engine exhaust emissions; Smoke; Fuel injection; Exhaust emission control; Hydrocarbons; Carbon monoxide; Nitrogen oxides; Emission standards

AVAILABILITY: SAE

HS-010 853 Fld. 5/6

## POWER LOSS DUE TO COMBUSTION CHAMBER DEPOSITS

by G. Cornetti; V. Liguori; G. Zanoni; L. Amendola

Published in *Journal of Automotive Engineering* v2 p8-14 (Jun 1971)

9 refs

Deposits in combustion chambers of spark ignition engines have long been known to limit performance, and search has been undertaken to determine how deposits form, what effects they have, and how to reduce their formation. Although recent techniques have provided some way to solving the problem, such as the complexity of the deposits, obtaining cycle repeatability, and the difficulty of obtaining accurate measurements inside of the chamber, have hindered a complete understanding of this problem, which can lead to losses of up to ten percent and engine damage through pre-ignition. The effects of brake thermal efficiency and additives are described.

Search terms: Combustion chamber deposits; Spark ignition engines; Engine performance; Pre-ignition; Power loss; Quench phenomenon; Quenching distance; Fuel additives; Engine operating conditions; Engine tests; Brake thermal factors

HS-010 854 Fld. 5/6

## DIESEL ENGINES TO MEET LAWS

by Alan Bunting

Published in *Journal of Automotive Engineering* v2 p11-5 (May 1971)

Petrol engine designers have had a share of problems in the last few years striving to cut down toxic emissions to the stringent levels imposed by Air Pollution Control authorities. For the diesel engine designer, pollution is only a single facet of the three-in-one legal requirement for engines fitted in road vehicles built after 1 October 1971 or put into service after 1 April 1972 onwards must conform with specified British standards on emissions, output and noise level as well as safety. In the case of existing engines, some manufacturers are faced with

prospect of having to reduce the horsepower rating of their diesels in order to bring the smoke and noise emissions within the prescribed limits.

Search terms: Diesel engine exhaust emissions; Smoke; Engine noise; Turbochargers; Horsepower; Engine performance; British vehicles; Noise standards; Air pollution laws; Emission standards; Engine design; Power output

#### HS-010 855 Fld. 5/6

#### OXIDATION OF GASEOUS HYDROCARBONS IN CONCENTRATIONS OF PARTS PER MILLION IN FLOW SYSTEMS. OXIDATION OF 1-BUTENE IN TYPE 410 STAINLESS STEEL TUBES

by E. E. Weaver; J. S. Ninomiya; L. M. Skewes; C. H. Ruof

Published in *Environmental Science and Technology* v3 n1 p57-62 (Jan 1969)

6 refs

Oxidation rates of 1-butene in concentrations of 7 to 350 ppm at 450°C - 800°C were studied in Type 410 stainless steel tubes. The rates in fresh tubes are independent of the surface-volume ratio, indicating that the reaction is largely homogeneous. The rates in aged tubes are an order of magnitude faster, suggesting that the tubes become increasingly catalytic with use. Thus, the metal exhaust systems of automobiles may become increasingly effective for the removal of hydrocarbons from exhaust gases upon prolonged use, particularly when nonleaded gasolines are used.

Search terms: Butene; Catalysis; Stainless steels; Hydrocarbons; Mathematical analysis; Oxidation; Exhaust gases; Exhaust emissions measurement

#### 5/7 Glazing Materials

#### HS-010 856 Fld. 5/7; 1/2

#### LE PARE-BRISE ET LA SECURITE ROUTIERE. WINDSCHUTZSCHEIBENENTWICKLUNG UNTER BERÜCKSICHTIGUNG DER MENSCHLICHEN TOLERANZEN (THE WINDSCREEN AND ROAD SAFETY. WIND-SCREEN-CONCEPTION DEVELOPMENT WITH REGARD TO HUMAN TOLERANCE)

by B. de Bodinat; H. V. Krings

Societe Francaise des Glaces de Securite; Vegla (West Germany)

Published in HS-010 808, *Conference on Road Safety. Vol. 2. Biomechanics of Accidents, Pt. 2*, Brussels, 1968 pA11-(1-13)

10 refs

Text in French and German. Summaries in English and Dutch.

The most recent official statistics worked out by the British Ministry of Transport show that about 13% of wounds, whether severe or slight, were caused by the glazing. Among points to be considered, can be mentioned the risk of cuts and the importance and duration of stresses and decelerations applied to the human body. Beyond certain relatively low speeds, it is impossible, without considerable danger, to make the windscreen alone absorb the whole kinetic energy of the passenger. It is explained that in impacts, only a popout windshield is adapted to human head and cervical column tolerances.

Search terms: Windshield caused injuries; Biomechanics; Kinetic energy; Injury causes; Popout windshields; Windshield impact tests; Cervical spine impact tolerances; Head impact tolerances; Glass caused injuries; Energy absorption; Deceleration caused injuries

#### HS-010 857 Fld. 5/7; 1/2

#### APPLICATION DU VERRE MINCE A RESISTANCE MECANIQUE ELEVEE POUR LA REALISATION DE PARE-BRISE DE HAUTE SECURITE (UTILISATION OF THIN GLASS, WITH HIGH MECHANICAL RESISTANCE, FOR THE MANUFACTURE OF HIGH-SECURITY WINDSCREENS)

by R. Van Laethem

Glaverbel S.A. (Belgium)

Published in HS-010 808, *Conference on Road Safety. Vol. 2. Biomechanics of Accidents, Pt. 2*, Brussels, 1968 pA12-(1-44)

22 refs

Text in French. Summaries in English, Dutch and German.

The new high security glass is made of two very thin (0.9 to 1.5 mm) sheets of high resistance glass held together by a thick (0.76 mm) layer of controlled adherence plastic. Comparative tests show the superiority of this new glass over conventional ones most noticeable in the following qualities: reduced weight, greater flexibility, reduced inertia effects in case of impact; high impact resistance, even in the case of repeated hits by pointed projectiles such as gravel stones, or by soft heavier objects, such as birds; visibility-retention in case the glass is broken by these projectiles; in moderate impacts from the inside, as by the head of a car occupant, appropriate breakage resistance, associated with low inertia and great flexibility, so that human impact tolerance limits should not be reached; in high-energy impacts from the inside, considerable increased resistance to penetration; danger of slashes or practically eliminated and gullies effect totally eliminated.

Search terms: Laminated glass; Tests; Windshield caused injuries;

## 5/7 Glazing Materials (Cont'd.)

### HS-010 857 (Cont'd.)

caused injuries; Animal experiments; Windshield impact tests; Injury prevention; Safety glass; Windshield design; Windshield penetration; Physical properties; Glass fracture behavior; Visibility; Test equipment

## 5/11 Maintenance and Repairs

### HS-010 858 Fld. 5/11

#### TAKE THE STING OUT OF WINTER MOTORING

by Keith E. Jolles

Published in *Nursing Times* v66 n53 p1681-4 (31 Dec 1970)

Careful inspection and a road test are first steps in preparing for winter. Following steps are thorough lubrication, adequate antifreeze in radiator and windshield washer, check of battery and lights, engine tuneup and oil change, checking tire treads, and mounting snow tires. Also discussed are snow removers, defrosters, overnight protection, waterproofing, maintaining good rear visibility, and parking techniques.

Search terms: Winter driving; Icy road conditions; Winterization; Preventive maintenance; Automobile maintenance

### HS-010 859 Fld. 5/11; 5/20; 4/5

#### COMPUTERIZED PREVENTIVE MAINTENANCE—IS IT WORTH-WHILE?

by William H. Baker

Georgia-Pacific Corp.

1971 9p

Report no. SAE-710668

Presented at the SAE National West Coast Meeting, Vancouver, 16-19 Aug 1971.

The costs of truck maintenance record keeping can be significantly reduced by the use of predesigned computer programs. Sufficient maintenance detail may be recorded, classified, and presented in a manner which will enable management to make meaningful maintenance evaluations of their fleet. These programs can provide historical as well as current maintenance data on each unit within a given fleet. Data, initially recorded on forms by the individual mechanic or driver, is edited by clerical people and electronically recorded. The records are then converted into specific maintenance cost reports classified by both vehicle and fleet.

Search terms: Computerized records management; Data processing; Preventive maintenance; Truck maintenance; Fleet management; Vehicle operating costs

#### AVAILABILITY: SAE

## 5/14 Occupant Protection

### HS-010 860 Fld. 5/14

#### PRODUCT SAFETY. A NEW ERA

by Victor W. Wigotsky

Published in *Design News* v26 n16 p13-6 (23 Aug 1971)

Government, industry, and the citizen are mutually involved in product design and safety. The automobile exemplifies accomplishments and problems in product safety: the use of government regulations and safety standards, based on the decision that improvements were easier to realize in the vehicle than in driver or road. Air bags have many problems and passive restraints such as cushioning and automatic belts are

suggested as preferable. Regulation of other products is increasing, although the appliance industry, at least, has a good record of voluntary improvement.

Search terms: Product safety; Safety design; Passive restraint systems; Consumer protection; Government industry cooperation; Energy absorption; Federal role

### HS-010 861 Fld. 5/14

#### CAR RESTRAINT DEVICES DESIGNED FOR CHILDREN

by Frederick D. Burg; John M. Douglass; Eugene Diamond; Arnold W. Siegel

Published in *Modern Medicine* p112-4 (8 Mar 1971)

A child's size and weight generally determine the most appropriate type of restraint for him. If an infant carrier is not used, babies weighing less than 12 pounds should be placed in a car bed in the back seat with the axis parallel to that of the car, the infant's feet pointed towards the front of the car. A net covers the bed and the middle front and rear seat belts are wrapped around the legs of the bassinet to secure it. From 12 to 24 pounds an adequately designed safety harness restraining the child across the high-chest and pelvic areas is recommended. From 25 to 50 pounds a shield type seat gives the best protection, but a good safety seat will be adequate. Children who weigh more than 50 pounds and who are less than 55 inches should use an adult safety belt but no shoulder harness. Any child taller than 55 inches may use both the adult seat belt and the shoulder harness.

Search terms: Child restraint systems; Infant restraint systems; Shoulder harnesses; Child safety seats; Child seat belts; Human body size; Human body weight

HS-010 862 Fld. 5/14; 1/3

**MANY AUTOMOBILE SAFETY ITEMS JUST GIMMICKS! POLICE LABEL AUTO HEADRESTS A "PAIN IN THE NECK"**

by Carl Wagner

Published in *Fleet Management News* v27 n3 p14-5, 18-20 (Mar 1971)

Review of an unpublished work, *The Other Side of the Story*, by Samuel J. Lee.

It is suggested that the Nader consumer crusade has attacked the results, rather than the causes, of highway accidents and that some safety devices are harmful rather than helpful. Restraint systems, especially headrests, are criticized. It is suggested that not enough attention has been paid to tire safety; that small cars are more dangerous because their occupants are more severely injured in accidents; that the design of highways is often hazardous; and that uniformity in traffic control is badly needed.

Search terms: Consumer dissatisfaction; Vehicle safety standards; Safety propaganda; Safety program effectiveness; Vehicle safety; Safety device effectiveness; Highway design; Highway accident potential; Roadside hazards; Accident causes; Restraint system effectiveness; Head restraints; Tire safety; Injury severity; Injuries by vehicle size; Compact automobile accidents; Traffic control device uniformity

HS-010 863 Fld. 5/14; 4/1

**RECENT SEAT BELT DECISIONS REVEAL JUDICIAL TREND IN CIVIL CASES**

by Edward C. Fisher

Published in *Traffic Digest and Review* v16 n6 p3-8 (Jun 1968)

All of the cases so far have emphasized that even though it might be found that a person is negligent in failing to use an available seat belt, such negligence could only relate to failure to use ordinary care to protect himself from injury, but could not be contributory negligence in the sense that it was a factor in causing the collision. Failure to use belts may be held to have contributed to injuries, but use also may cause adverse effects. Many courts hold failure to fasten one's seat belt as not pleadable in defense, because of the absence of duty to use it; a few courts allow the plea, with the jury to decide the effect. As of 1967, no state required use of seat belts, and in three the statutes provided that failure to use them shall not be deemed negligence.

Search terms: Seat belt legal factors; Seat belt usage; Court decisions on seat belts; State laws; Litigation; Negligence; Seat belt regulations; Injury severity

HS-010 864 Fld. 5/14; 5/7; 1/2

**FORWARD FORCE COLLISIONS WITH EMPHASIS ON WINDSHIELD IMPACTS. FINAL PROGRESS REPORT**

by Lawrence M. Patrick

Wayne State Univ.

1971 22p 6 refs

Safety performance of the interior components of automobiles in frontal force collisions is measured quantitatively by a combined field investigation and experimental program. Only frontal force collisions resulting in injury to a front seat occupant, for which the component causing the injury could be determined and the degree of injury ascertained, and resulting in measurable deformation of the vehicle interior were included. Injuries of known degree were correlated with measured deformities of

steering columns or instrument panels, and external vehicle deformations recorded as TAD indexes. Observed speeds and collision stopping distances were duplicated in laboratory simulations with the WHAM II accelerator on identical vehicles and instrumented dummies and cadavers. Fewer tears and jagged edges occurred with the 30 mil interlayer windshields (as opposed to the pre-1966 15 mil interlayer), and fewer injuries with energy-absorbing steering columns. Better instrument panel design could prevent still more injuries.

Search terms: Deformation; Injury causes; Accident severity; Front end collisions; Damage severity index; Injury prevention; Injury severity; Injury statistics; Steering wheel caused injuries; Windshield caused injuries; Instrument panel caused injuries; Head injuries; Occupant protection; Restraint systems; Impact tests; Dummies; Cadavers; Energy absorbing steering columns

5/15 Propulsion Systems

HS-010 865 Fld. 5/15

**THE TWO-STAGE ROTARY ENGINE—A NEW CONCEPT IN DIESEL POWER**

by Fritz Feller

Published in *Journal of Automotive Engineering* v2 p9-14 (Jan 1971)

2 refs

To meet a military requirement for an engine of low specific bulk and low fuel consumption to replace existing two-stroke opposed piston engines, Rolls Royce embarked on a program of research. The design resulting is a two-stage rotary engine based on the Wankel principle but operating on the compression ignition cycle. The author relates the development of this 250 bhp engine from the decision to adopt the Wankel

# 5/15 Propulsion Systems (Cont'd.)

HS-010 865 (Cont'd.)

principle, through the early experiments, to the production of the completely original two-stage engine with possibilities of double banking to requirements of up to 1,000 bhp.

Search terms: Engine design; Diesel engines; Rotary engines; Wankel engines; Military vehicles; Engine performance; Combustion chamber design; Two stroke cycle engines; Engine size; Weight to power ratio

HS-010 866 Fld. 5/15

## PRESENT BATTERIES FOUND LACKING. GM AND FORD CELLS STILL IN LAB—STATUS OF BATTERY RESEARCH

Published in *SAE Journal* v76 n12 p61-71 (Dec 1968)

Types of batteries described are: metal air; zinc air; lithium chlorine; sodium sulfur; lithium tellurium. Other types of batteries are listed. No battery fills the requirements for automotive powerplants, high energy and power densities. Several pairings warrant consideration for this role: lithium-organic electrolyte cells, metal-air cells, and high temperature cells. The nickel-cadmium pair will see increased use probably in hybrid systems. Battery suitability for electric cars is mentioned.

Search terms: Performance characteristics; Batteries; Electrolytes; Fuel cells; Electric automobiles; Hybrid batteries; Nickel cadmium batteries; Metal air batteries; Lithium chlorine batteries; Zinc air batteries; Lithium tellurium batteries; Sodium sulfur batteries

# 5/18 Steering Control System

HS-010 867 Fld. 5/18

## THE STABILITY OF ARTICULATED VEHICLES

by H. A. Wilkins

Published in *Journal of Automotive Engineering* v2 p13-7 (Mar 1971)

2 refs

Two types of accidents apply particularly to articulated vehicles: overturning and jackknifing. Of these, jackknifing is more serious, as recovery is virtually impossible. Trailer swing, in which the trailer swings out of line with the intended path, can constitute a very serious danger to other road users. Many attempts have been made to render articulated vehicles safer by use of anti-lock braking systems and better dynamic control of the tractor trailer unit. These problems are analyzed and three solutions suggested: anti-lock brakes, load sensing brake valves, and king pin friction devices.

Search terms: Articulated vehicles; Jackknifing; Tractor trailers; Wheel locking caused accidents; Anti-jackknifing devices; Antilocking devices; Mathematical analysis; King pins; Load modulation values; Truck accidents; Truck overturn accidents; Truck stability; Sideslip; Wheel locking; Brake systems

HS-010 868 Fld. 5/18

## ON AMPLITUDE DEPENDENCE OF DYNAMIC DAMPERS TO CONTROL VIBRATION OF UNSPRUNG MASSES OF MOTOR VEHICLES

by Ken-ichiro Omata; Hideo Fukuda

Published in *Bulletin of the Society of Automotive Engineers of Japan* n3 p82-92 (Mar 1971)

6 refs

Taking into account the amplitude dependence of vehicles, the optimum conditions of the dynamic damper to control vibration of the unsprung masses

of the vehicles are studied. It is found that desirable dynamic dampers are obtained by air damping as well as the damping of rubber itself.

Search terms: Shock absorbers; Vibration; Spring damping; Vehicle mass; Acceleration damping; Rubber; Torsion; Mathematical analysis; Damping

HS-010 870 Fld. 5/18; 5/20

## THE SNOWMOBILE SUSPENSION—A HIGH-SPEED MOTION PICTURE STUDY

by James A. Newman; David J. Beale

Ottawa Univ. (Canada)

1971 8p

Report no. SAE-710667

Presented at the SAE National West Coast Meeting, Vancouver, 16-19 Aug 1971.

A high-speed motion picture analysis of a typical snowmobile suspension system has been conducted. The bogie wheel system at the vehicle track and the leaf springs at the skis have both been examined as the vehicle traversed a prescribed ground profile. The technique has proven to be quite useful in determining the effectiveness of the suspension system. Several tentative recommendations for improving vehicle stability are made as a result of this study.

Search terms: Motion pictures; Snowmobile design; Suspension systems; Springs; High speed photography; Vehicle stability

AVAILABILITY: SAE

**5/20 Trucks and Trailers****HS-010 871 Fld. 5/20****PROTECTION OF DRIVERS OF LORRIES AND AGRICULTURAL TRACTORS IN CASE OF OVERTURNING OR IMPACT**

by G. Ekberg

Sweden National Road Safety Board

Published in HS-010 808, *Conference on Road Safety. Vol. 2. Biomechanics of Accidents, Pt. 2*, Brussels, 1968 pA13-(1-15)

Summaries in French, Dutch and German.

Rapidly expanding use of tractors in Sweden has resulted in a large number of accidents, mostly overturns. Investigations have been carried out to determine minimum strength requirements for protective frames or cabs on the tractor. The equipping of tractors with an approved type of frame or cab has been compulsory in Sweden for a number of years. These have proven very effective. The strength of drivers' cabs on heavy trucks has also been investigated. Protection was needed against penetration by a shifting load or crushing in an overturn. Tests have been made to establish suitable testing methods and to determine strength requirements for truck cabs.

Search terms: Farm tractor design; Truck overturn accidents; Load shifting; Truck cabs; Truck design; Tractor cabs; Sweden; Rollover protective structures; Occupant protection; Impact tests; Static tests

**HS-010 872 Fld. 5/20****RECREATIONAL VEHICLE ENGINES AND THEIR INSTALLATION**

by Harry I. Hazzard

McCulloch Corp.

1971 11p

Report no. SAE-710664

Presented at the SAE National West Coast Meeting, Vancouver, Canada, 16-19 Aug 1971.

The subject of the engine for recreational vehicles is approached first as the selection and installation of the engine in units such as the snowmobile and A.T.V.'s. This is to aid the vehicle's engineer in selecting and adapting an engine to his project. Then engine design is considered; particularly, McCulloch's balanced power engine with its mechanical balance system.

Search terms: Snowmobiles; Snowmobile design; Engine design; Two stroke cycle engines; Noise control; Engine noise; Exhaust noise; Engine mounts; Engine operating conditions; Engine size; Engine performance; Recreational vehicles; Deflection; Vibration

**AVAILABILITY: SAE****HS-010 873 Fld. 5/20****SOUND LEVEL AT OPERATOR'S STATION OF CAB AND NON-CAB EQUIPPED TRACTORS**

by D. E. Walker

Deere and Co.

1970 12p

Report no. SAE-700703

Presented at Combined National Farm, Construction and Industrial Machinery and Powerplant Meetings, Milwaukee, 14-17 Sep 1970.

The various sound sources that produce the overall sound level at operator's station are discussed. The effect of adding partial and full operator enclosures is also discussed along with factors affecting sound level inside enclosures. Absorption curves for cab lining materials and decay rates for damping materials are given.

Search terms: Noise control; Noise exposure; Engine noise; Mufflers; Vehicle noise; Sound absorbing materials; Tractor cab interiors; Exhaust noise; Engine operating conditions; Damping

**AVAILABILITY: SAE****HS-010 874 Fld. 5/20****WHY A MEDIUM SIZE FOUR WHEEL DRIVE AGRICULTURAL TRACTOR?**

by L. K. Davis; D. L. Henderson

Deere and Co.

1970 9p 9 refs

Report no. SAE-700683

Presented at the Combined National, Farm, Construction and Industrial Machinery and Powerplant Meetings, Milwaukee, 14-17 Sep 1970.

Medium size four-wheel drive tractors are becoming popular as farmers strive to increase productivity per man day. Limited crop planting time has created a need for tractors able to operate in many soil conditions without excessive slippage or compaction. These tractors represent the next step up in horsepower with only a moderately higher cost per horsepower than available large two-wheel drive tractors. This paper describes how a four-wheel drive tractor using two-wheel drive tractor components minimizes cost.

Search terms: Four wheel drive vehicles; Farm tractor design

**AVAILABILITY: SAE****HS-010 875 Fld. 5/20****FUTURE TRENDS IN CV DESIGN**

by Carlos M. Carreras

Published in *Journal of Automotive Engineering* v2 p3-6 (May 1971)

**5/20 Trucks and Trailers (Cont'd.)**

**HS-010 875 (Cont'd)**

Although regulations relating to commercial vehicle design are still far from standardized, there is a definable trend, particularly in Europe, towards heavier vehicles, with greater load carrying capacity to meet the demands of containerized transportation. Aspects described are: maximum axle weight; maximum gross vehicle weight; power to weight ratio; smoke and noise; trends in axle design; engine power; clutches and gear-boxes; and cab design.

Search terms: Commercial vehicles; Articulated vehicles; Weight to power ratio; Noise standards; Smoke; Truck design; Vehicle size; Gear boxes; Europe; Turbocharging; Vehicle weight limits; Containerization; Axle loads; Power output; Engine size; Clutches; Truck cab interiors

**HS-010 876 Fld. 5/20; 5/3**

**TECHNICAL ASPECTS OF THE TRANSITION FROM MOTORCYCLES TO SNOWMOBILES**

by Leo Lake

Yamaha International Corp.

1971 10p

Report no. SAE-710665

Presented at SAE National West Coast meeting, Vancouver, Canada, 16-19 Aug 1971.

Snowmobile use and environment dictates many mechanical innovations in the cylinder, electrical, fuel supply, and drive systems. The end result and the reasons behind each successive component mutation are studied as is the present product. Specific components of the snowmobile are evaluated with respect to the motorcycle background from which they were developed by Yamaha.

Search terms: Japanese vehicles; Snowmobile design; Motorcycle electric systems; Fuel systems; Electric systems; Drive systems; Motorcycle design

**AVAILABILITY: SAE**

**HS-010 877 Fld. 5/20; 5/18**

**FCIM INDUSTRY IS MAKING CONCERN FOR THE OPERATOR A HIGH-PRIORITY OBJECTIVE**

Anonymous

Published in *Automotive Engineering* v79 n9 p23-32 (Sep 1971)

Manufacturers of farm, construction, and industrial machinery are giving increasing consideration to operator safety and comfort. Rollover protective structures on heavy construction and industrial equipment are discussed. A mathematical model has been developed to simulate sideways overturning of farm tractors. Other aspects briefly discussed are: tower crane monitoring systems, an electronic overload warning system for mobile cranes, safety signs for attachment to the machinery, a lower noise level for modular cabs, and cab air conditioning.

Search terms: Construction vehicles; Heavy duty vehicles; Cranes; Vehicle stability; Rollover tests; Air conditioning; Tractor cabs; Warning signs; Noise control; Warning systems; Farm tractor design; Mathematical models; Occupant protection; Rollover protective structures; Simulation models

**5/22 Wheel Systems**

**HS-010 869 Fld. 5/22; 5/18; 4/7**

**THE LOAD DEPENDENCE OF SIDE FORCE AND SELF-ALIGNING TORQUE OF PNEUMATIC TIRES**

by A. Schallamach

Published in *Rubber Chemistry and Technology* v43 n5 p995-1004 (Sep 1970)

12 refs

It is concluded from analysis of the load dependence of side force and self-aligning torque that agreement between experimental and theoretical side force curves does not necessarily prove the soundness of the theory. However, even an inadequate theory is successful in suggesting a predictable and useful interrelation between load and slip dependence of the side force. The purposes of this article are to show a theoretically expected interaction between load and slip dependence and the transformation of a family of curves into a single master curve.

Search terms: Tire slip motion; Tire loads; Tire side forces; Mathematical models; Torque

**HS-010 878 Fld. 5/22**

**NEW AREAS FOR TIRE PERFORMANCE METHODS**

by Leonard Segel; K. C. Ludema; H. J. Dugoff

Published in *Materials Research and Standards* v8 n6 p10-9 (Jun 1968)

35 refs

Mechanical characteristics of tires are identified as one of the two major aspects of tire performance of concern to the vehicle designer. Relationships between tire compliance, interfacial shear force, and characteristics of the tire-road interface are fundamental to the vehicle control and guidance process. Accordingly, an attempt is made to



identify the requirement for measuring the combined cornering and braking performance of tires in the near-skid regime. The state of knowledge and the art of measurement are discussed relative to the variables that describe the operating environment for the tire and exercise major influence on the shear forces acting within the tire contact print. There is a pressing need to adopt indirect measures of the interfacial variables until research provides more definitive understanding of their measurement and control.

Search terms: Tire mechanics; Tire performance; Tire characteristics; Tire forces; Tire road contact forces; Tire pavement interface; Tire road conditions; Tire slip motion; Tire tests; Tire properties; Mechanical properties; Vehicle guidance; Vehicle control

HS-010 879 Fld. 5/22; 2/9; 4/1

**HIGHWAY SAFETY, DESIGN AND OPERATIONS. WET WEATHER PERFORMANCE, STUDDED TIRES, LACK OF UNIFORM TRAFFIC LAWS. HEARINGS BEFORE THE SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT, MAY 18-21, 1971**

Congress. House Public Works Com.

1971 320p  
Report no. 92-9

92nd Congress, 1st Sess.

Testimony deals with: skidding and tire skid resistance; pavement surfaces and their skid resistance; studded tires in relation to safety and to pavement wear; lack of traffic law uniformity; comparisons between state laws and the Uniform Vehicle Code; and a sensor device which photographs speeding vehicles and records their speed.

Search terms: Uniform Vehicle Code; Law uniformity; Traffic laws; Highway

design; Automated law enforcement systems; Speed sensors; Wet road conditions; Skidding; Tire skid resistance; Studded tires; Tire traction; Stopping distance; Pavement wear; Pavement damage; Pavement surface texture; Pavement skid resistance; State laws; Tire safety

AVAILABILITY: GPO

## NHTSA DOCUMENTS

### NHTSA Contractors Reports

HS-800 617 Fld. 1/3

**MULTIDISCIPLINARY ACCIDENT INVESTIGATION. FINAL REPORT 1970-71**

by William J. Fogarty; Sudduth; Freeman; Carole Haviland; Paul Vilardi; Brian Blackbourne

Miami Univ., Fla.

1971 223p 14 refs

Contract FH-11-7224

A compilation of data collected during the nine months from May 1, 1970 to January 31, 1971 is presented. An attempt has been made to categorize case elements into human, environment, and vehicle related elements, and to subdivide these into precrash, at-crash, and postcrash phases. Team responsibilities are given, community factors are mentioned, a compilation of qualitative and quantitative cause and effect factors by case number is shown, data are summarized, and recommendations, categorized in the manner of the case elements, are listed. Hypothetical forecasting of social hour traffic accidents is briefly discussed. Twenty-five case summaries are included. Social factors involved in severe car crashes, including use of alcohol and other drugs, as well as family situation, education, and community standing and responsibility of the driver are studied. Summary of findings and Dade County data together with exhibits of field forms are shown.

Search terms: Miami; Multidisciplinary teams; Accident factors; Precrash phase; Crash phase; Postcrash phase; Environmental factors; Human factors; Accident case reports; Accident causes; Accident risk forecasting; Driver characteristics; Alcohol usage; Sociological factors; Blood alcohol levels; Driver age; Drugs; Psychological factors; Fatalities; Interviews; Questionnaires; Accident statistics; Accident types; Time of accidents; Age factor in accidents; Injuries; Accident location; Light conditions; Drinking drivers

AVAILABILITY: NTIS

HS-800 620 Fld. 1/3

**MULTIDISCIPLINARY ACCIDENT INVESTIGATION. FINAL REPORT**

by John D. States; John C. Balcerak

Rochester Univ.; Rochester Applied Science Associates, Inc.

1971 329p 4 refs

Contract FH-11-7422

Report for 1 Jul 1970-30 Sept 1971.

Methodology and findings of multidisciplinary accident investigation of 43 cases are discussed, and conclusions and recommendations derived from analysis of these cases are given. Vehicle, human, and environmental factors were analyzed. The results and relationship of federal safety standards are described. It was found that present vehicle side structure provides inadequate protection for occupants in lateral impact; that fire after collisions is infrequent although fuel leakage occurs regularly; that advances in instrument panel design have alleviated injury severity to front seat occupants but improvement is needed in the lower part of the instrument panel; that usage rates for lap and torso restraints were about the same as that of the general motoring public, so that passive restraints are needed; that

**NHTSA Contractor's Reports  
(Cont'd.)**

HS-800 620 (Cont'd.)

present deterrents to drinking drivers are inadequate.

Search terms: Multidisciplinary teams; Accident investigation; Accident causes; Accident factors; Safety standards; Occupant protection; Injury severity; Accident case reports; Accident caused fires; Vehicle fires; Fuel tank leakage; Environmental factors; Human factors; Crash-worthiness; Side impact collisions; Instrument panel design; Front seat passengers; Seat belt usage; Restraint system usage; Drinking drivers; Alcohol usage deterrents; Passive restraint systems; Driver age; Driver sex; Defects; Crash phase; Precrash phase; Postcrash phase; Accident location; Accident types

**AVAILABILITY: NTIS****NHTSA Staff Speeches, Papers, etc.**

HS-810 192 Fld. 3/1

**REMARKS BEFORE THE KICK-OFF LUNCHEON OF THE OKLAHOMA CITY ALCOHOL SAFETY ACTION PROJECT**

by James E. Wilson

National Hwy. Traf. Safety Administration

1972 12p

Four approaches towards controlling drunk drivers are being used: national public education; research and development; Alcohol Safety Action Projects; and alcohol countermeasures in present state highway safety programs. Each is briefly described.

Search terms: Alcohol usage deterrents; Alcohol Safety Action Projects; Alcohol education; Highway safety programs; Drinking drivers; Driver intoxication

**AVAILABILITY: NHTSA****NHTSA Imprints**

HS-820 180 Fld. 4/8; 4/4

**DEPARTMENT OF TRANSPORTATION FIFTH ANNUAL REPORT. FISCAL YEAR 1971**

Department of Transp.

1972 231p

Report no. DOT-AR-5

Areas of the Department of Transportation's work described are: legislation; safety and accident prevention; environmental improvement; planning and formulation of national transportation policy; efforts to improve social conditions; research and development; program developments; international transportation developments; emergency and national defense transportation; organizational and administrative developments. All forms of transportation are included: highway, motor carrier, aviation, railroad, and marine.

Search terms: Annual reports; Department of Transportation; Laws; Safety research; Safety programs; Accident prevention; Environmental research; Transportation planning; Highway transportation; Highway safety; Marine transportation; Air transportation; Rail transportation; Motor carriers; International factors; Emergencies; National defense; Sociological factors

**AVAILABILITY: GPO \$1.00**

# U.S. DEPARTMENT OF TRANSPORTATION

## NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Research Institute, Office of Accident Investigation and Data Analysis

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